How to Write a Critically Appraised Topic (CAT)

Gelareh Sadigh, MD, Robert Parker, ScD, Aine Marie Kelly, MD, MS, Paul Cronin, MD, MS

Medical knowledge and the volume of scientific articles published have expanded rapidly over the past 50 years. Evidence-based practice (EBP) has developed to help health practitioners get more benefit from the increasing volume of information to solve complex health problems. A format for sharing information in EBP is the critically appraised topic (CAT). A CAT is a standardized summary of research evidence organized around a clinical question, aimed at providing both a critique of the research and a statement of the clinical relevance of results. In this review, we explain the five steps involved in writing a CAT for a clinical purpose ("Ask," "Search," "Appraise," "Apply," and "Evaluate") and introduce some of the useful electronic resources available to help in creating CATs.

Key Words: Evidence-based medicine; evidence-based radiology; critically appraised topic; levels of evidence; literature search; systematic review.

Medical knowledge has expanded rapidly over the past 50 years. Many subcategories of disease, diagnostic testing, and treatment strategies are now known. Paralleling this improvement in medicine, the volume of scientific articles published has exploded and is doubling every 10 years (1). Therefore, evidence-based practice (EBP) and publications in this area have developed to help health practitioners keep up to date with the increasing volume of information to solve complex health problems (1).

One of the main formats for sharing information in EBP is the critically appraised topic (CAT). A CAT is a standardized summary of research evidence organized around a clinical question, aimed at providing both a critique of the research and a statement of the clinical relevance of results (2). In other words, CATs are not just abstracts of existing evidence. They critique the internal validity, external validity (generalizability), and statistical rigor (or methodology) of the best research evidence to date and summarize the results into a few pages (2,3). In contrast to systematic reviews, which are written by content and methodology experts, CATs may be more easily written by clinicians and practitioners (3). Critically appraised topics provide easy access to the scientific literature for clinicians who are either too busy to pursue the answer to a clinical problem among the mixed results from a search engine or do not have the specialized skill to critically appraise the literature and reach an appropriate conclusion (2).

Acad Radiol 2012; 19:872–888

From the Division of Cardiothoracic Radiology, Department of Radiology, University of Michigan Health System, University of Michigan B1 132G Taubman Center/5302, 1500 East Medical Center, Ann Arbor, MI 48109-5302 (G.S., A.M.K., P.C.); Department of Biostatistics, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, MI 48109 (R.P.). Received August 23, 2011; accepted February 3, 2012. **Address correspondence to:** P.C. e-mail: pcronin@med.umich.edu

doi:10.1016/j.acra.2012.02.005

The main reason to produce a CAT is to answer an explicit clinical question arising from a specific patient encounter, and is the essence of EBP in that a health professional generates a clinical question from a real clinical situation, followed by finding and appraising the evidence, and finally applying it in clinical practice (1).

In this review, we start by explaining the steps involved in writing a CAT for a clinical purpose and introduce some of the available electronic CAT makers.

HOW TO WRITE A CAT?

Writing a CAT involves five steps along the five steps of evidence-based practice which can be summarized as "Ask," "Search," "Appraise," "Apply," and "Evaluate" (4). These steps are:

1. Asking a focused and answerable question that translates uncertainty to an answerable question
2. Searching for the best available evidence
3. Critically appraising the evidence for validity and clinical relevance
4. Applying the results to clinical practice
5. Evaluation of performance

Step 1: Ask an Answerable Question

The first step in writing a CAT is to formulate a well-built question regarding the clinical problem or knowledge gaps (decisions regarding patient's diagnostic workup, treatment, or intervention). To benefit patients and clinicians, such questions need to be both directly relevant to the patients' problems and phrased in ways that direct the search to relevant and precise answers. This involves taking a clinical question and changing its format so that the literature search is based on this question (5,6). The question needs to be important to the patients' well-being, the clinicians' knowledge needs, of interest to the patient, clinician, or the learners, likely to recur in clinical practice, and answerable in the time available (7).

The majority of questions formulated to start a CAT are foreground questions, consisting of four components: 1) patient's problem of interest; 2) the main intervention (eg, a diagnostic test, or treatment) that is going to be compared with the existing reference standard; 3) the comparison intervention (diagnostic test or treatment) that is already identified; and 4) outcome of interest. These components can be abbreviated to PICO (patient, intervention, comparator, and outcome) (5). The finished question can be expressed in a single, clear and focused sentence (eg, "In patients with … how does … compare with … for the outcome(s) of … "). Sometimes there is no comparator intervention, and the question becomes PIO (8), or sometimes there is more than one comparator intervention or outcome. Some examples of foreground questions in radiology that generated a CAT and their PICO format are shown in Table 1 (6,9,10).

In diagnostic radiology, CAT questions may relate to the superiority of one imaging method over another in resolving clinical dilemmas and/or the power of imaging signs to reliably confirm or exclude a suspected disease processes. In interventional radiology, CAT questions are related to the short-, medium-, and long-term benefit/harm of new interventional techniques compared with older interventional methods or more invasive procedures.

Step 2: Search for the Best Current Evidence

The second step in writing a CAT is to perform a thorough search of the literature. To conduct a good search, one has to be familiar with the types and sources of information available, the levels of evidence and where to look for a particular type of evidence, and how to select articles with a high level of evidence. It is important when searching for evidence that search terms are referred back to the original PICO question (11). Examples of radiology CAT search strategies are shown in Table 2 (10,12–14). The process of searching for and finding the best current evidence therefore follows three key steps:

1. Identify terms to fit the PICO question
2. Search for secondary sources
3. Search for primary sources

Primary study designs. The goal of a primary research study, whatever design used, is to provide valid and generalizable data. Validity is internal to the study: the results are true for the population studied, and are not the result of bias or confounding. Generalizability (or applicability) is the ability to apply the results of the study to a broader population, hopefully including the population group of interest. Validity is a precondition for generalizability: if there are significant questions about whether the study results are valid, there is no information which can be applied to other populations.

The major factor affecting the validity of a study is bias. Bias means that the results of the study reflect other factors, in addition to and distinct from those that are formally being studied. As a simple example of a bias, if an investigator enrolled patients into a study and deliberately assigned those with a worse prognosis to the experimental arm to ensure that he would not be overestimating the potential benefit, the study would be biased. This assignment would minimize the observed benefit of the experimental treatment compared to the control group, biasing the results.

Compared to other research designs, the potential for bias is minimized in the randomized double-blind clinical (or controlled) trial, so it is the design most likely to provide valid data. As such, this design is considered as providing the best evidence on a question. This is because of two features mentioned in the name: randomization and double-blinding. Randomization is a process by which participants in the study are allocated after enrollment to either the intervention or the control group in a random manner. Implicit in this description is that no one knows which treatment the participant will receive until after the participant is enrolled. This eliminates any potential for the investigator or the patient to enroll into the study to receive a specific treatment, although most participants are likely to enroll in the hope of receiving the experimental treatment. This helps ensure that the intervention and control groups are similar in terms of both known and unknown prognostic factors. Double-blinding (sometimes called double-masking) is when both the participant and the outcome assessor do not know which treatment the participant is receiving. This reduces potential bias (generally toward an improvement) because of participant factors involved in knowingly receiving an experimental treatment, and potential bias if the assessor were determining outcome for a known treatment. Randomization also helps reduce the possibility of confounding, which is when an apparent treatment effect (or the lack of a treatment effect) is caused by another variable. Confounding requires that the variable be associated with both the treatment and with the outcome, but that it not be part of the mechanism of action of the treatment on the outcome. Randomization ensures that any variable related to outcome should on average be similar in the treatment groups. In addition, the temporal order is clear—the intervention in the randomized clinical trial precedes the outcome. Many textbooks have been written on clinical trials (15–17).

Other study designs, which collectively are called observational studies, have more potential for bias and thus run a greater risk of having validity problems than the randomized double-blind clinical trial. Even a randomized single-blind clinical trial (where the participant or the assessor but not both are blinded to treatment) is more prone to bias. Prospective cohort studies, where data are collected prospectively but participants are not randomized to exposure (or intervention) are generally considered the next best design in terms of validity, but suffer as do all the other designs mentioned in the following section, from potential confounding because